2005

Values And Objectivity In Science: The Current Controversy About Transgenic Crops

Hugh Lacey
Swarthmore College, hlacey1@swarthmore.edu

Introduction

This book is a sequel to *Is Science Value Free? Values and Scientific Understanding* (Lacey 1999/2004; hereafter referred to as *SVF*). I introduced in *SVF* a general model of the interplay of science and values that enables us to identify clearly the ways in which values legitimately play a role in scientific practices and the ways in which they do not. I was interested, however, not only in the impact of values on scientific methodology, but also (though this was much less developed) in how scientific practices and results may have impact in the realm of values, in how, for example, science may have implications for and contribute to the quest for social justice and human well-being. In this present book, the question of how to conduct scientific practices for the sake of furthering human well-being informs the overall argument.

Part I does deal with questions of scientific methodology. It strengthens some of the arguments made in *SVF*, draws new consequences that flow from the general framework concerning how scientific results are to be interpreted, argues for the methodological importance of applied science, and deepens arguments in favor of methodological pluralism by bringing to the forefront questions that must be addressed in order to legitimate applications of scientific knowledge—all so as to show that the quest for objectivity in science is not incompatible with conducting science for the sake of furthering human well-being. Then, in part II, I bring the analysis of methodology developed in part I to bear on a current controversy with far-reaching ethical and social implications: whether transgenic crops should be used widely and, if not, what forms of farming provide suitable alternatives to using them. Through drawing on this analysis, we gain a rich understanding of the scientific, ethical, and political dimensions of the controversy and of how the dimensions interact with one another. At the same time, all the themes of part I are illustrated, especially as they concern the conduct and institutionalization of scientific practices. Throughout part I, I anticipate various fea-

tures of the discussion to follow in part II, introducing them where convenient from chapter to chapter, in order to illustrate, to stimulate, and to give concrete texture to the general philosophy of science being developed; and also in order to be in a position to make soundly based recommendations about how to respond to the controversy.

The analysis of the transgenics controversy, in the light of my general model of the interplay of science and values, is the most distinctive feature of this book, and it is intended to have impact on public discussion. But the argument of the book will not be dated when the controversy no longer captures attention, for that is not what the book principally is about. It is about my model of the interaction of values and scientific practices, and about making sense of science as a historical and social phenomenon. It is a test of the explanatory power and significance of my model that it makes sense of the actual historical outcome of the transgenics controversy, whatever it may be. Another, ultimately more important, test is whether the analysis can be generalized to make sense of a wide range of scientific developments and controversies, and whether some of the alternative kinds of scientific practices to which the analysis points can be developed into flourishing areas of research and practice.

SUMMARY OF THE CONCLUSIONS OF *IS SCIENCE VALUE FREE?*

The principal theme of *SVF*, as its title makes apparent, is the analysis and critical appraisal of the widely held view that science is value free. In order to locate the contribution of this book, it will be helpful to recall the central theoretical concepts and to state the most important conclusions of the earlier book. I will do this by presenting a list of the principal theses that were defended in it.

> Thesis 1: The idea that science is value free is best understood as a combination of claims about three key aspects of scientific practices—the acceptance of theories and the knowledge claims that are represented in them, the consequences of applying scientific knowledge, and scientific methodology—that I call respectively: impartiality, neutrality, and autonomy; it is well captured by the thesis: impartiality, neutrality, and autonomy are constitutive values of scientific practices and institutions—where, among other things, impartiality presupposes that there is a distinction between cognitive and social (ethical and other kinds of non-cognitive) values, and neutrality presupposes that scientific theories have no value judgments among their logical implications.

This thesis, and the presuppositions of impartiality, neutrality, and autonomy, will be re-articulated in a sharper and more elegant manner in chapter 1 of this book.

After extensive argument, I concluded:

> Thesis 2: Only impartiality can be unambiguously upheld. It expresses the value: to accept a theory of a domain of phenomena if and only if it manifests the cognitive values to a suitably high degree in the light of relevant available empirical data, and to reject a theory if and only if it is inconsistent with a soundly accepted theory; hence there is no proper role for ethical and social values, alongside the cognitive values, in making judgments of theory acceptance. In contrast, autonomy is not a realizable value; and neutrality—that, overall and in principle, the application of scientific knowledge serves value-outlooks evenhandedly—is compromised within mainstream scientific practices, but could be more fully manifested if scientific research were conducted under a suitable plurality of methodological approaches.

The key to my argument lay in introducing, as an element in the analysis of scientific methodology, in addition to "theory" (hypothesis) and "empirical data," what I call a "strategy":

> Thesis 3: (a) Scientific research is always conducted under a strategy, whose main roles are, first, to prescribe constraints on the kinds of theories (and the kinds of categories they may deploy) that may be entertained and investigated, and thus to specify the kinds of possibilities that may be identified in the course of the research, and, second, to select the relevant kinds of empirical data to seek out and report, and the phenomena and aspects of them that are to be observed and experimented upon. (b) The aim of science permits that successful research may be conducted under a variety of kinds of strategies.

But:

> Thesis 4: Modern scientific research has been conducted almost exclusively under particular kinds, of strategies (albeit a considerable variety of them), those I call "materialist strategies," under which theories are constrained to those that represent phenomena and encapsulate possibilities in terms of their being generable from underlying structure (and its components), process, interaction, and the laws (characteristically expressed mathematically) that govern them; and, by virtue of obtaining them as products of measurement, instrumental, and experimental operations, empirical data are generally quantitative,

Representing phenomena under materialist strategies decontextualizes them, by dissociating them from any place they may have in relation to social arrangements, human lives and experience, from any link with value, and from whatever social, human, and ecological frameworks in which they may be embedded. In this book, I call the kinds of possibilities that can be encapsulated under materialist strategies "decontextualized possibilities" (or, as I called them in *SVF*, "material possibilities"). In order to illustrate that not all possibilities that may

be identified in systematic empirical inquiry (whose results accord with impartiality) are reducible to decontextualized possibilities, I used the examples of human agency and agroecology. Research conducted on human and agroecological phenomena under respectively "feminist strategies" (*SVF*, chapter 9) and "agroecological strategies" (chapter 8) has produced knowledge in accordance with impartiality, but under these strategies phenomena are not dissociated from their human/social/ecological contexts, and so the possibilities that are identified for them are not decontextualized.

> Thesis 5: Scientific research—systematic empirical inquiry that produces results that are in accordance with impartiality—may be conducted (for some domains of phenomena) under strategies that, while they may freely utilize results consolidated under materialist strategies, are not reducible to materialist strategies.

Thesis 5, backed by the illustrations, confirms that including (b) in Thesis 3 is not merely an abstract logical point.

Theses 4 and 5, then, lead us to pose the questions: How do we explain the fact that modern scientific research has been conducted almost exclusively under materialist strategies? And: Are there good reasons for conducting research in this way? After considering and rejecting a variety of answers that have been put forward, I concluded:

> Thesis 6: (a) The almost exclusive adoption of materialist strategies in modern science is explained (i) by their fruitfulness and potential for practically unlimited further development, (ii) by the fact that there are mutually reinforcing relations between adopting them and holding a set of social values, specifically the modern valuation of control, and (iii) by the fact that the modern valuation of control is widely upheld throughout advanced industrial countries and highly embodied in their leading institutions. (b) There are good reasons for the privilege that materialist strategies have gained only to the extent that there are good reasons to uphold the modern valuation of control.

The modern valuation of control refers to a set of specifically modern values connected with the control of natural objects, having to do with expanding the scope of technological control, its value not being systematically subordinated to that of other ethical and social values, and the degree of its penetration into modern lives, experience, and institutions. It and its presuppositions are discussed more fully in section 1.1. It does not follow from this thesis that materialist strategies are always adopted because of an interest to further the modern valuation of control, or that movement from one kind of materialist strategies to another can be explained by reference to these social values. Thesis 6 concerns the almost exclusive adoption of materialist strategies in modern science, and it relates this to particular social values being widely upheld. Item (b) is crucial.

Where the modern valuation of control is contested, there can be no objection (in principle) to adopting strategies in research in virtue of their mutually reinforcing relations with other values (subject, of course, to providing reasons to uphold these values). Then, we can see Thesis 6 to be a particular case of the more general:

> Thesis 7: Social values may provide a compelling reason to adopt a particular kind of strategy: adopt strategies in view of mutually reinforcing relations that adopting them may have with holding specific social values. In practice, this may mean: adopt strategies under which valued kinds of possibilities (if there are any) can be systematically identified and the means for realizing them discovered, or that have the potential to produce results that, on application, can further the interests defined by the values—subject always to the conditions of (i) fruitfulness, (ii) the results gained being in accord with impartiality, and (iii) the recognition that it is not evidence against the genuineness of a possibility that it cannot be identified under a favored strategy.

Feminist values may provide a good reason to adopt "feminist strategies," and the values of "popular participation," widely held values within movements of small-scale farmers and rural workers in many of the impoverished regions of the world, may provide a good reason to adopt "agroecological strategies" (see section 5.4 and part II of this book). Thesis 7 goes hand in hand with:

> Thesis 8: The moment of deciding to adopt a strategy may be logically separated from that of choice to accept or reject a theory (of a specified domain of phenomena) constructed under the strategy, so much so that commitment to impartiality can be maintained at the latter moment, even though social values may have a legitimate role at the first moment. Moreover, the social values in play at the first moment may be the same values whose furtherance is served at a third moment, that of the application of scientific knowledge.

Theses 7 and 8 together sum up the general model of the interplay of science and values that I referred to at the outset.

Research conducted under one kind of strategy may complement that conducted under another by, for example, exploring possibilities of things that cannot be considered because of the constraints of the other. But strategies may also compete (e.g., for resources), and this may make it socially impossible for research to be conducted simultaneously and in a probing way under conflicting strategies. Thus, if one kind of strategies is privileged because of its links with predominant social values, this may lead to inability even to recognize that there is a choice of strategy to make. Specifically:

> Thesis 9: So strong is the grip of materialist strategies in modern science that it is often not appreciated that there may be certain domains of phenomena (e.g.,

agriculture), which are of special salience where the modern valuation of control is contested, but whose possibilities cannot be adequately encapsulated in theories confirmed in research conducted under materialist strategies, although they can be under other kinds of strategies (e.g., agroecological strategies).

With this in mind, I introduced:

Thesis 10: The aim of science is best served by institutionalizing scientific practices so that a plurality of strategies, linked respectively with different social values, may be actively pursued. This would also make possible the fuller manifestation of neutrality and giving better attention to value issues raised by applications, and, above all, be conducive to strengthening the institutions of democratic participation.

THE PLAN OF THIS BOOK

Part I

These theses all remain intact in this book, and I will make use of them frequently. In chapter 1, I will recapitulate the arguments in favor of them, clarify them in various ways, emphasize how they are illustrated by the competition between agroecological and materialist strategies, and anticipate the conclusions of later chapters. The other chapters of part I provide arguments complementing those of *SVF* and draw further implications from the theses concerning both how to understand and how to conduct scientific practices. In chapter 2, I will show that there need not be conflict between the traditional ideal of scientific objectivity and the conduct of scientific inquiry for the sake of furthering social justice and human well-being. In chapter 3, I address a gap in the argument of *SVF*. My defense of impartiality, which draws on the presupposition that there is a significant distinction between cognitive and social (ethical and other kinds of) values, has been criticized. In this chapter I offer a sustained defense of the importance of the distinction. In the course of doing so, new insights arise about important methodological issues connected with applications of scientific knowledge. Distinguishing between the efficacy and legitimacy of proposed applications, and reinforcing the importance of Thesis 10, I show that legitimacy depends on endorsing hypotheses (e.g., about risks to human health and the environment, and about the availability of alternative efficacious means to realize the objective of the application) that lie beyond the purview of research conducted under materialist strategies. The significance of this conclusion is made apparent throughout part II.

In chapter 4 and chapter 5 I explore more fully the implications of the pluralism that I have proposed. What is the range and variety of strategies that could or should be developed? I do not attempt to answer this question fully; to do so

would require a vast number of case studies in fields like psychology, medicine, and energy policy. I do suggest in chapter 4, however, drawing upon the case study of agriculture, that a wide range of cultural values may legitimately have impact on the kinds of strategies that one adopts, so that there are legitimate culture-based variations in approaches to scientific practices. Then, in chapter 5, developing this argument and making use of a detailed account of agroecological strategies, I consolidate the conclusion that there are rich dialectical links between methodology and application, so much so that it is often impossible to separate the interpretation of scientific results from the social location in which the research is conducted. From this, it follows that scientific practices exhibit historicity: that their character changes, and must change, in fundamental ways that arise historically, through being responsive to and shaped significantly by historical and cultural variations in the realm of daily life and experience and in the structures of social practice.

The arguments I make in part I—for strategic pluralism, for there being (often and legitimately) mutually reinforcing relations between adopting strategies and holding particular social values, and for the historicity and sociocultural shaping of scientific practices—are arguments in the philosophy of science. They draw principally upon my statement of the aim of science (section 3.2) and my exploration of how to further the manifestation of the widely acclaimed scientific ideals of impartiality and neutrality. In order to show that this plurality represents more than an abstract possibility (Thesis 5), I introduced the case of agroecological strategies (detailed in section 5.4) as a concrete illustration. Agroecological strategies are not reducible to materialist strategies, and adopting them has mutually reinforcing relations with holding the values of popular participation (characterized in section 6.3). The soundness of the argument in part I does not depend on holding any particular ethical/social values (apart from those implicit in the aim of science). My highlighting of agroecological strategies does reflect my own commitment to the values of popular participation. This commitment, however, is irrelevant to the appraisal of the fruitfulness of these strategies; and also the facts that they are not reducible to materialist strategies, and that these values contest the modern valuation of control, are irrelevant to this appraisal.

In part I, the role of agroecological strategies is to provide an example that shows that there are actual instances of what philosophical analysis identifies to be possible (a plurality of fruitful strategies). Other strategies, for example, in the psychological, social, or medical sciences, could have played this role just as well. In part II, the role of agroecological strategies is essential; knowledge gained in investigations conducted under them is indispensable for making important ethical judgments about the legitimacy of using transgenics; and development of the farming practices that agroecological knowledge informs is important for the consolidation of democratic ideals.

Part II

In part II, drawing on the conclusions of part I, I offer an interpretation of current controversy about transgenic crops and alternative types of farming such as agroecology. The controversy is about the legitimacy of research, development, practical agricultural implementation of transgenics, and practices and policies (pertaining to transgenics) that currently are being implemented under the sponsorship principally of agribusiness corporations. I take the pro-transgenics side to argue for the legitimacy (and importance) of the development, immediate implementation, intensive utilization, and widespread diffusion of transgenics in the agricultural practices that produce major crops, throughout the world as soon as possible, and for support for transgenics to become a central plank in national and international agricultural policies. And I take the con side to deny that the pro conclusions have been adequately established; to maintain that more research is needed before a definitive position can be taken; and positively, to prioritize alternatives that do not use transgenics, such as agroecology, and the urgency and priority of investigating their productive potentials.

My interpretation identifies the principal points of contention (while recognizing, since there is a variety of opinions in play on both sides, that it involves a certain amount of idealization). This is a prerequisite to exploring what would have to be done (if anything can be) to bring about—or to show that there are insuperable obstacles to bringing about—a resolution of the dispute. It involves two steps: first, identifying four pairs of contrary propositions that are in dispute (section 6.2)—pro: P_1–P_4 and con: C_1–C_4; and, second, sketching the value-outlooks that are implicated, respectively, in the two positions (section 6.3). The propositions are about strategies for research in agricultural science (discussed in detail in chapter 7), benefits (chapter 8) and risks of using transgenics (chapter 9), and whether there are better alternatives (chapter 10):

Strategies for Research in Agricultural Science

P_1 Developments of transgenics are informed in an exemplary way by scientific knowledge, that is, they are informed by knowledge gained in research conducted under appropriate versions (biotechnological) of materialist strategies; they are instances of techno-scientific developments, which are the principal sources of improvements of agricultural practices and (more generally) meeting human needs.

C_1 The kind of knowledge gained under materialist strategies is incomplete and cannot encompass the possibilities of, for example, sustainable agroecosystems and the possible effects of uses of transgenics on the environment, people, and social arrangements; it is necessary to adopt other strategies in order to investigate these matters.

Benefits of Using Transgenics

P_2 There are great benefits to be had from using TGs now, and these benefits will greatly expand with future developments, among which are promised TG crops with enhanced nutritional qualities that can readily be grown in poor developing countries so that TGs may become key to addressing problems like those of hunger and malnutrition. When these promises are fulfilled, the benefits of TGs will become spread evenhandedly so as (in principle) to serve the interests and to improve the farming practices of groups holding any viable value-outlooks.

C_2 The benefits claimed for currently used TGs reflect the ethical/social values of agribusiness, large-scale farmers, and others who are beneficiaries of the global market. Furthermore, not only are the benefits relatively slight (perhaps even exaggerated by the proponents), being confined largely to these groups and not extending to small-scale farmers in the "developing" world (or to organic farmers in the advanced industrial societies), but also the promises made about future benefits are not credible, in part because developments of TGs reflect the interests of the global-market system, the very same system within which poverty, the fundamental cause of hunger and malnutrition, persists today.

Risks of the Development and Use of Transgenics

P_3 There are no hazards to human health or the environment arising from the current and anticipated uses of transgenic crops and their products that pose risks—of seriousness, magnitude, and probability of occurrence sufficient to cancel the alleged value of their benefits—that cannot be adequately managed under responsibly designed regulations.

C_3 This claim about risks is not well established scientifically. Moreover, the greatest risks may not be direct ones to human health and the environment mediated by biological mechanisms, but those occasioned by the socioeconomic context of the research and development of transgenics and their associated mechanisms, such as designating that transgenic seeds are objects to which intellectual property rights may be granted.

Alternative (or "Better") Forms of Farming

P_4 There are no alternative kinds of farming that could be deployed instead of the proposed transgenic-oriented ways without occasioning unacceptable risks (e.g., not producing enough food to feed and nourish the world's growing population), and that reasonably could be expected to produce greater benefits concerning productivity, sustainability, and meeting human needs—"transgenics are necessary to feed the world."

C_4 Agroecological methods (and other alternatives) can be and are being developed that enable high productivity of essential crops (and occasion relatively less risk); and they promote sustainable agroecosystems, utilize and protect biodiversity, and contribute to the social emancipation of poor communities. Furthermore, there is good evidence that they are particularly well suited to ensure that rural populations in "developing" countries are well fed and nourished, so that without their further development current patterns of hunger are likely to continue.

By identifying these as the key points of contention, I hope to have interpreted the dispute so that a perspicuous contrast is made between the two sides, one that meets the following conditions: (i) each side can acknowledge that its position has been fairly represented; (ii) each side is enabled to recognize the internal coherence of the other, to identify clearly what lies behind the disagreements, and to raise questions about the evidence and arguments that support the various propositions; (iii) avenues that might lead to resolution, which are in continuity with the basic commitments of each side, become opened for exploration.

Implications of the Interpretation

Although I think that my interpretation meets these conditions, this does not mean that I abstain from taking positions on the propositions. There is good reason—I will argue, again with grounding in the conclusions of part I—to endorse C_1 (methodological pluralism) (chapter 7), that now P_3 and P_4 lack the support that they need in order to play their role in arguments legitimating uses of transgenics (chapter 9 and chapter 10, respectively), and that there is urgency to conduct research relevant to test the limits of the promise of alternative agricultural methods, expressed in C_4 (chapter 10). That is enough to deny legitimacy at the present time to projects aimed at the widespread implementation of transgenic-oriented agriculture throughout the world. But it also is part of my argument that the legitimacy of the transgenics project in the long run depends on the outcomes of testing the limits of C_4 (section 10.4), so that using my interpretive framework does not guarantee that the opponents of transgenics will be vindicated in the long run.

The interpretive framework sets up a context in which empirical investigation, conducted under a plurality of strategies (including agroecological ones), could play a major role in cutting through the disagreements about risks (P_3/C_3) and alternative types of farming (P_4/C_4). Conducting this kind of research would inform ethical deliberation in two ways, by providing knowledge (a) for appraising presuppositions of the legitimacy of using transgenics on a wide scale at the present time, and (b) for informing agroecological innovations that are important for bringing about greater manifestation of the values of popular participation. Thus, engaging in research conducted under agroecological strategies is

likely, because of (a), to further the manifestation of impartiality and, because of (b), of neutrality; and so, adopting strategies, which have mutually reinforcing relations with the values of popular participation, is likely to contribute to the furtherance of acclaimed scientific interests. According to my interpretation, the con argument is not an abstract one, and it does not involve merely negative criticism of mainstream science, since it is also rooted in critical reflection on the practices of agroecology. It enables a positive case to be made for the scientific significance of the knowledge that informs agroecological practices and for the value of research that strengthens them. It is part of a philosophical perspective that interprets and supports both the practices and the research conducted to inform them (as having a proper place—alongside others—within scientific practices), and it defends their credentials from criticisms that they are "unscientific." So it is an interpretation that confronts the predominant self-image of contemporary science with the sound claims of an alternative practice. The strength of the argument goes hand in hand with the value and viability of the alternative practices.

Does the Authority of Science Provide Backing for the Pro Transgenics Side?

I said that I wanted an interpretation in which each side would acknowledge the portrayal made of it. I have taken seriously the pro side's claim to have the backing of science. Obviously developments of transgenics are products of research conducted under materialist (biotechnological, molecular biological) strategies, and their efficacy (within certain domains) has been confirmed by this research. In addition, I take the pro side to claim scientific backing for the key propositions about risks and alternatives that are important for legitimating uses of transgenics. I argue (chapter 9; chapter 10) that at the present time there is not strong empirical backing for P_3 and P_4, since relevant inquiries (that I specify)—requiring the use of a plurality of strategies—pertaining to risk have not been conducted, and others pertaining to alternatives have effectively been ignored. But, by endorsing P_1, the pro side tends to identify scientific research with research conducted under materialist strategies, and so it does not recognize the possibility (and, in this case, necessity) of scientific research conducted under a plurality of strategies. (Thus, it tends to interpret the con side as "unscientific" or even "antiscientific.") I will suggest that endorsing P_1 is a consequence of holding the modern valuation of control and endorsing its presuppositions (section 9.2); then the absence of strong empirical backing for P_3 and P_4 (and accepting that there is a strong presumption in their favor) derives, not from scientific evidence, but in part from a value commitment, that has presuppositions (e.g., that techno-scientific solutions can be found for virtually all socially significant problems, and that there are no significant possibilities for value-outlooks, not incorporating the modern valuation of control, to be actu-

alized in the foreseeable future—section 1.1) that themselves cannot be investigated under materialist strategies.

At the same time as the pro side claims the backing of the authority of science, it also represents the interests of leading institutions of capital and the market that dominate the world economy today. Another way to look at its endorsement of P_1, and its endorsement of the presuppositions of the modern valuation of control, is that they derive from endorsing that there are no significant (valued) possibilities for the foreseeable future outside of the trajectory of the institutions of capital and the market. Then (section 10.6), the pro argument could be strengthened, since it would appear to marginalize the relevance of C_3 and C_4, by replacing P_4 with P_4a:

P_4a: There are no alternative kinds of farming—*within the trajectory of the socioeconomic system based on capital and the market*—that could be deployed instead of the proposed TG-oriented ways without occasioning unacceptable risks (e.g., not producing enough food to feed and nourish the world's growing population), and that reasonably could be expected to produce greater benefits concerning productivity, sustainability, and meeting human needs; *and outside of this trajectory there are no genuinely realizable agricultural possibilities.*

P_4a may be taken to express a political-economic commitment and, given the constraints it states, empirical research might contribute to vindicate it; and, given the economic and political power linked with it, it might be expedient simply to dismiss the con side as a nuisance. Then the authority of science would be subordinated to the political values and power embodied in this trajectory. Alternatively, the pro side might claim to endorse P_4a on empirical grounds and, in this way, to reclaim the authority of science. Clearly the con side would oppose it on both counts.

Part III

In the public debates about transgenics, the pro side often moves imperceptibly back and forth between P_4 and P_4a. Responding to P_4, the con side emphasizes the fruitfulness of research conducted under agroecological strategies and the promise of agroecological approaches to farming; responding to P_4a, it affirms the viability of the movements that embody the values of popular participation and their potential to grow with a trajectory that could nurture new kinds of social structures. Thus, for the con side, the development of research conducted under agroecological strategies, the development and improvement of agroecological farming, and the activities and growth of movements that embody the values of popular participation are inseparably linked.

These considerations all raise the question of how propositions like P_4a, the presuppositions of the modern valuation of control, and other questions about future social possibilities—as well as the various contrary propositions that would be affirmed by the con side—can be investigated in a systematic empirical way. Under what kinds of (social science) strategies would the investigations have to be conducted? The answer to this question, and the outcomes of the research, are relevant to attempts to resolve the controversies about transgenics in ways that make use of the input of scientific (systematic empirical) investigation to the utmost. Those with power on their side have not waited for an answer before going ahead with the rapid and widespread introduction of transgenics; consequently the con side often finds itself in a negative reactive mode, opposing what is happening. That should not obscure the continuing importance of investigating further the promise contained in C_4. Evidence for C_4 directly challenges the empirical credentials of P_4, but it also remains important that there be movements that challenge P_4a. The possibility of manifesting values like those of popular participation to a greater degree depends on there being genuine alternative practices (in agriculture as well as other areas) that may reflect these values, and the latter depends on social and political action that claims and gains more and expanding spaces for these practices, expansion that is not possible without successfully challenging P_4a.

In the brief part III, I begin to entertain questions about how to investigate future social possibilities. I do just enough to make clear that the conclusions of part I, especially those about strategic pluralism and mutually reinforcing relations between adopting strategies and holding values, will play an important role in answering them. I can do no more than this within the scope of this book.